2018 Research Report

from the

Saskatchewan Oat Development Commission

Project Title:
Oat Vigour Improves with Larger Seed Size
(ADOPT# 20170417)

Principal Investigators:

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Project Identification

1. **Project Number:** 20170417
2. **Producer Group Sponsoring the Project:** Saskatchewan Oat Development Commission
3. **Project Location(s):** Yorkton and Indian Head, Saskatchewan.
4. **Project start and end dates (month & year):** April 2018 to February 2019
5. **Project contact person & contact details:**

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Objectives and Rationale

6. **Project Objectives:**

The objective of this project was to demonstrate how seedling vigour of oats can be improved by screening out smaller less vigorous seed. Increasing the average seed size of a seed lot should result in greater emergence, improved stand establishment, greater competitiveness against wild oats, earlier maturity and greater yield.

7. **Project Rationale:**

Planting vigorous seed is the first step towards producing a high yielding, milling quality oat crop. Vigorous seed provides better stands, particularly under stressful conditions such as cold soils, deeper than optimal seed placement, and heavy weed competition (ie: wild oats). Oats grown from vigorous seed are more competitive against wild oats. This is particularly important when wild oat populations are high as there are no herbicides available to control wild oats in tame oats. A simple means by which producers can improve the vigor of their own seed lots is to have it cleaned more aggressively to assure small less vigorous seeds are removed. This has potential to increase economic returns for oat growers.

Methodology and Results

8. **Methodology:**

Field trials using CS Camden oats were direct seeded near Yorkton and Indian Head to establish the treatments listed in table A. Treatments were replicated 4 times and only the middle rows of each plot were harvested to minimize the influence of edge effects. Different parts of the treatment list were analyzed as two separate factorial experiments. The first factorial analysis used treatments 1-9 and evaluated 3 seed sizes of large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed) at 3 seeding rates of 100, 200 and 300 seeds/m^2. The 3 seed sizes were sieved from the same seed lot. At Yorkton, the second factorial analysis used treatments 2, 5, 9, 10, 11 and 12 to evaluate the 3 seed sizes at shallow and deep seeding. At Indian Head, only treatments 2, 5, 9 and 10 were used to evaluate 2 seed sizes (large and small) at shallow and deep seeding. Data from the unscreened seed was omitted as there was a seeding error for treatment 12. Both unscreened treatments 11 and 12 were omitted to balance the trial for a factorial analysis. All treatment comparisons for the second factorial analysis were seeded at 200 seeds/m^2. The dates of various operations can be found in table B.

Table A. Treatment list for oat vigour improves with larger seed size.

Trt.	**Seed Size**	**Seeding rate (Seeds/m^2)**	**Seeding depth (inches)**
1	Large	100	Shallow (1”)
2	Large	200	Shallow (1”)
3	Large	300	Shallow (1”)
4	Small	100	Shallow (1”)
5	Small	200	Shallow (1”)
6	Small	300	Shallow (1”)
7	Unscreened	100	Shallow (1”)
8	Unscreened	200	Shallow (1”)
9	Unscreened	300	Shallow (1”)
10	Large	200	Deep (2-3”)
11	Small	200	Deep (2-3”)
12	Unscreened	200	Deep (2-3”)

Table B. Dates of operations in 2018 for the Oat Vigour Improves with Larger Seed Size

Operations in 2018	Indian Head	Yorkton
Seeded	May 7	May 10
Tame Oat Emergence (4 by 0.5 m)	May 28	May 28
In-crop Herbicide	June 6 (Buctril M)	June 8 (Prestige)
Tame Oat Biomass	June 5	June 7
Fungicide at Flag	June 25 (Quilt)	June 25 (Caramba)
Wild Oat Rating	July 18	July 20
Harvest	August 10	August 30

9. Results:

Growing Season Weather

Mean monthly temperatures and precipitation amounts for Yorkton and Indian Head are listed in Table C. Mean temperatures were above the long term average and rainfall was well below. However, yields were still respectable at Indian Head and exceptional at Yorkton.

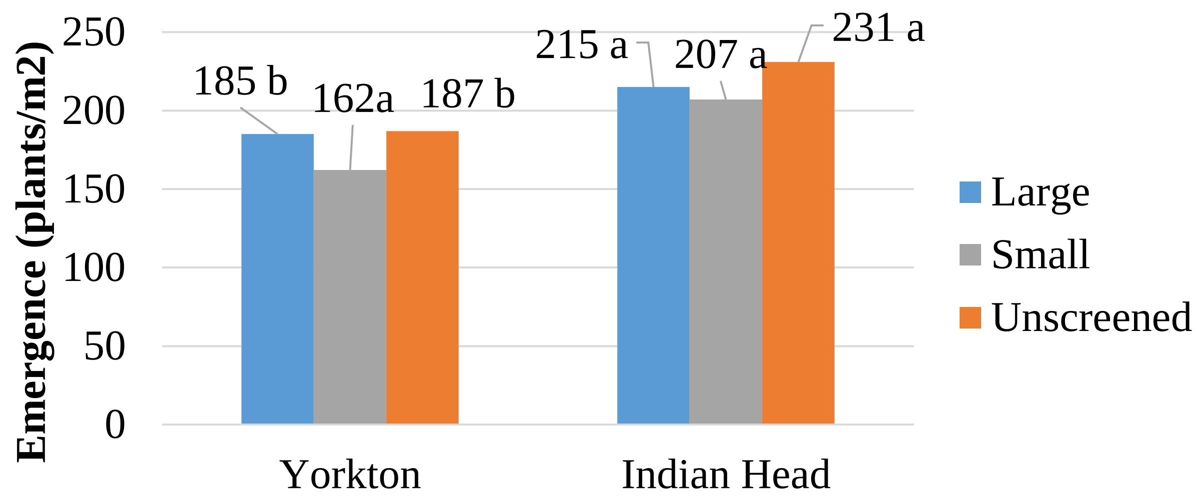
Table C. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2018 growing seasons at Indian Head and Yorkton in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		-----------------------------*Mean Temperature (°C)* ---------------				
Indian Head	2018	13.9	16.5	15.4	17.6	15.8
	Long-term	***10.8***	***15.8***	***18.2***	***17.4***	***15.6***
Yorkton	2018	13.9	17.6	18.3	18.1	17.0
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***
		-------------------------------- *Precipitation (mm)* ------------------				
Indian Head	2018	23.7	90	30.4	3.9	148
	Long-term	***49***	***77.4***	***63.8***	***51.2***	***241.4***
Yorkton	2018	0.8	120.1	53.8	21.1	196.1
	Long-term	***51***	***80***	***78***	***62***	***272***

Tables 1-12 showing results from both factorial analyses for Yorkton and Indian Head are found in the appendices.

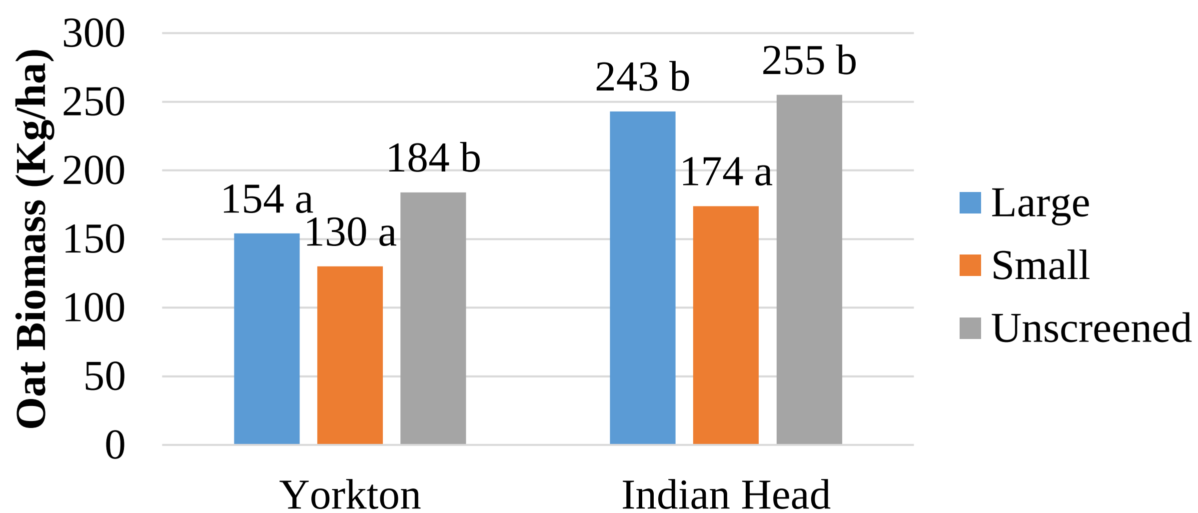
Target seeding rates of 100, 200 and 300 seeds/m^2 resulted in average plant populations of 109, 182 and 243 plants/m^2, respectively at Yorkton (Table 2) and 122, 214 and 316 plants/m^2, respectively at Indian Head (Table 5). At Yorkton and Indian Head, emergence of oats from small seed was the poorest and produced less early season biomass (Tables 2, 5 and Figures 1 and 2).

Figure 1. Effect of Seed Size on Oat Emergence (plants/m2), averaged over seeding rate[1]



[1]Seed sizes are large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed)

Figure 2. Effects of Seed Size on Oat Biomass (Kg/ha), averaged over seeding rate[1]



[1]Seed sizes are large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed)

Compared to large seed, emergence for Oats from small seed was 13% poorer at Yorkton and 4% poorer at Indian Head. Likewise, early season biomass for oats from small seed was 16% lower at Yorkton and 29% lower at Indian Head. Differences in emergence could, to a certain extent, potentially reflect improper calibration or random variability in sampling error. However, the reduction in above grown biomass is greater than the reduction in emergence suggesting the smaller seed oats were less vigorous. This was visually obvious at Yorkton as figure 3 shows the difference in early vegetative growth between small and large size oat seed when planted deep. Seeding deeper tended to further reduce emergence and early season biomass at both locations (Tables 8 and 11). Emergence and early season biomass did not differ between large and unscreened oats, indicating the removal of smaller seed was insufficient to greatly improve the quality of the seed lot. This was likely due to the fact that the seed lot was of very high quality to begin with, as evident in the very similar TKW values for the large and unscreened seed.

For the most part, early season oat biomass increased significantly as seeding rate was increased at both Yorkton and Indian Head (Tables 2 and 5). This is intuitive as more plants emerging should mean more biomass when measurements are taken early in the season. However, there was an unexpected interaction with the biomass data at Yorkton which the author can not explain. As expected, the biomass increased as seeding rate increased for oats from large seed and unscreened seed (Table 3). However, the opposite was true for oats grown from small seed. As seeding rates were increased from 200 to 300 seeds/m^2, oat biomass dropped from 169 to 118 kg/ha.

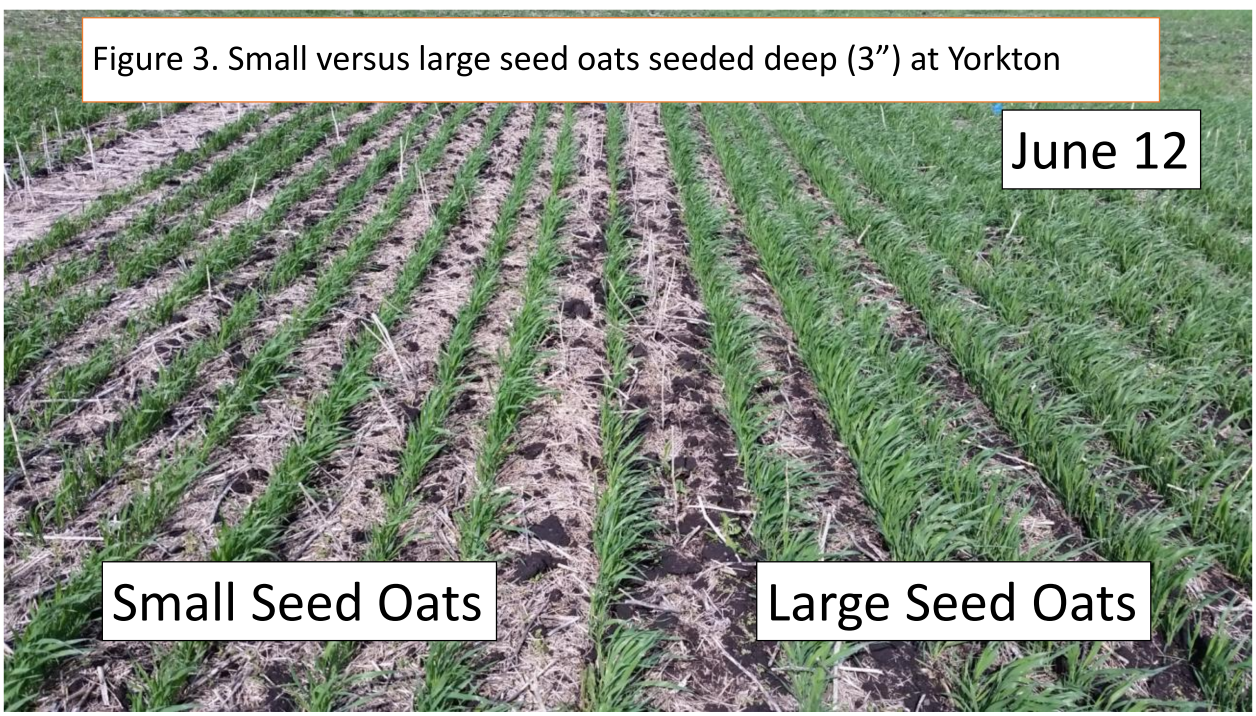
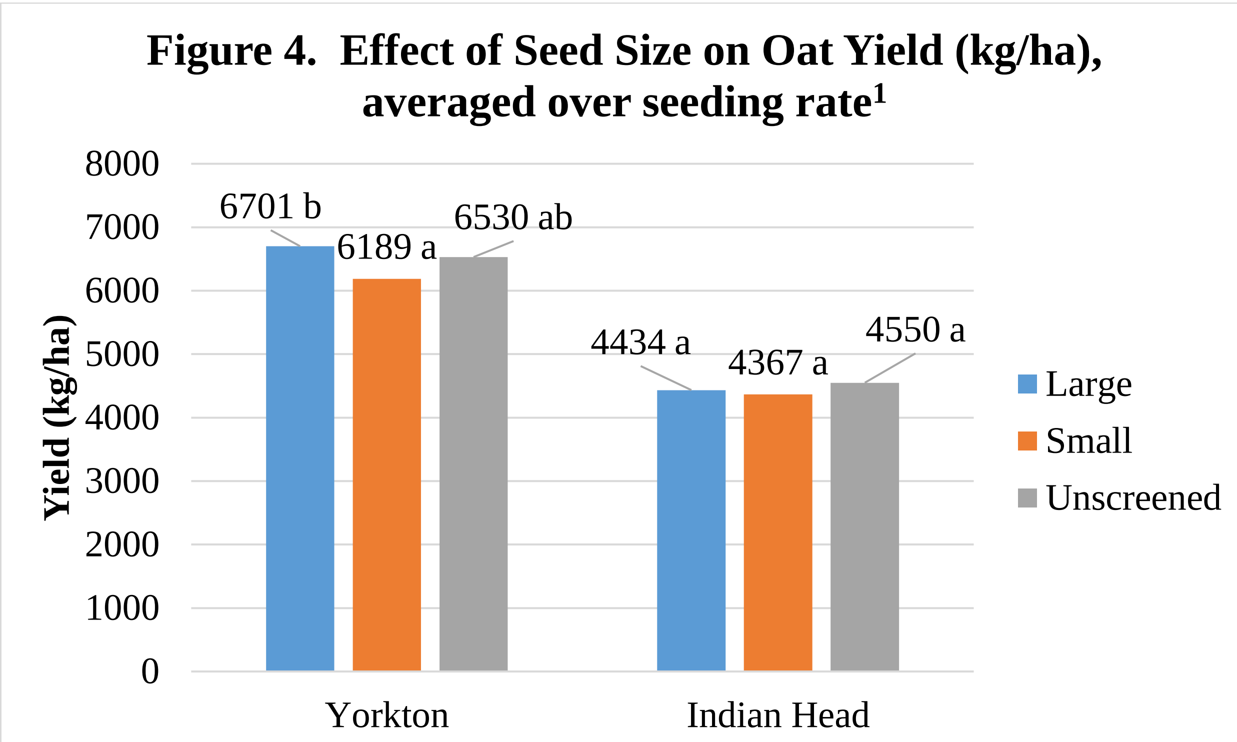


Figure 3. Small versus large seed oats seeded deep (3”) at Yorkton

Although oats from large seed emerged more vigorously at both locations, this only resulted in significantly higher yields at the Yorkton site (Tables 2 and 5 Figure 4). At Yorkton, oats from large seed significantly yielded 8% more than oats from small seed size, but only 2.6% more than unscreened oats which was not statistically significant. At Indian Head, small seed size oats did yield the least, but differences between the seed sizes were small and insignificant.

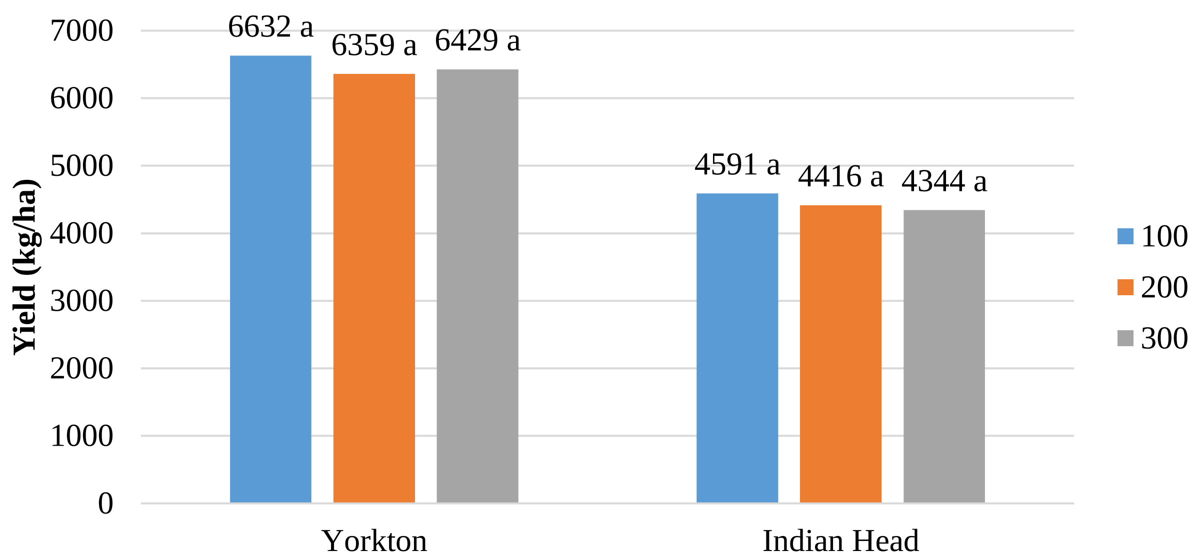


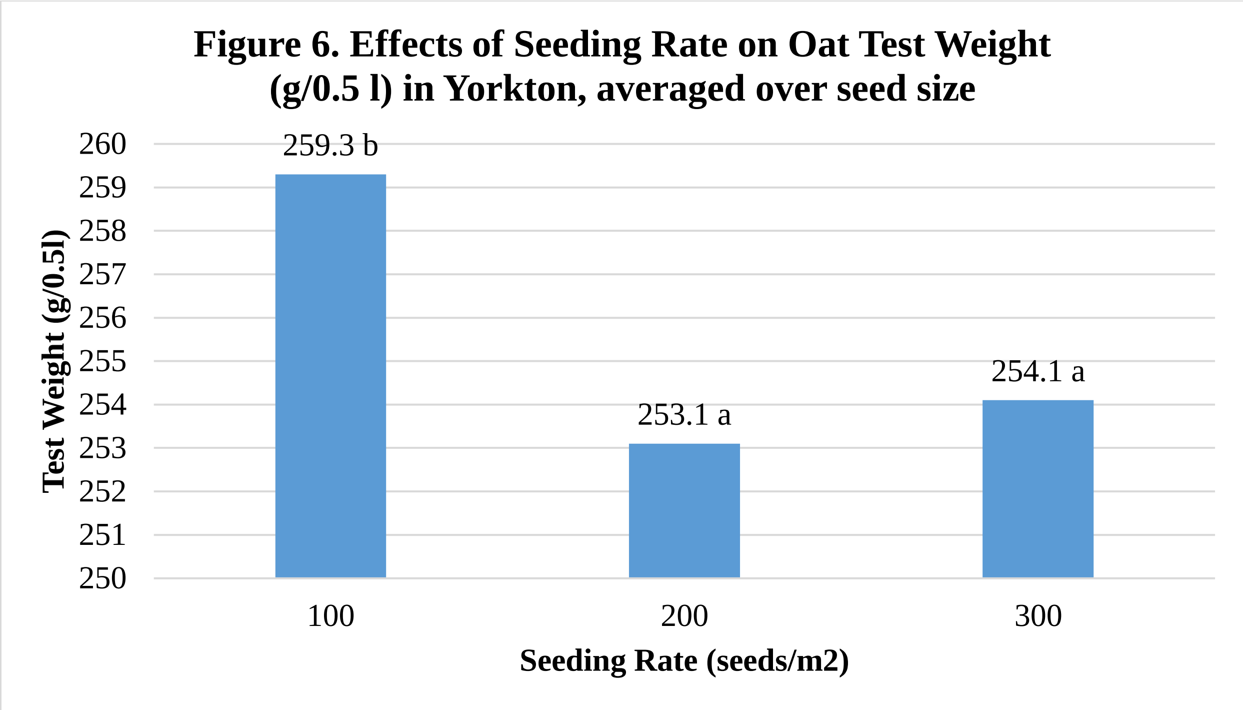
[1]Seed sizes are large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed)

While increasing seeding rates did not significantly affect yield, the highest yields were numerically associated with the lowest seeding rate at both Yorkton and Indian Head (tables 2 and 5, Figure 5). The seeding rate of 100 seeds/m^2 is far below the recommended rate of 300 seeds/m^2. Perhaps lower plant populations benefitted from less inter-plant competition for water as conditions were dry, especially in Indian Head. Increasing seeding rates had little affect on yield in this study but should still be recommended as it improved competition with wild oats and hastened maturity. While wild oat pressures were low at both locations, increasing seeding rate from 100 to 300 seeds/m^2 did significantly reduce wild oat pressure from a visual rating of 1.5 to 0.5 out of 10 at Indian Head. No differences were detected at Yorkton as wild oat populations were quite low (data not shown). Maturity ratings were lost at Yorkton, but increasing seeding rate from 100 to 300 seeds/m^2 significantly hastened maturity by 4 days at

Indian Head. Maturity was also significantly affected by seed size (Table 5) and seeding depth (Table 11). Seeding deep and seeding oats with a small seed size statistically delayed maturity, but the differences were within a day and not agronomically important. Test weights were not a required measure for this study but this data was collected from the Yorkton site. While not statistically significant, tests weights were numerically higher for oats grown from large seed and statistically higher for oats grown at the lowest seeding rate (Table 2 figure 6). The observed test weights were well above the minimum of 240 g/0.5 l required for milling oats.

Figure 5. Effect of Seeding Rate (seeds/m^2) on Yield (kg/ha), averaged over seed size





10. Conclusions and Recommendations

The small seed size oats were found to be less vigorous and oats grown from this seed produced lower yield at Yorkton. However, removing these seeds from the original seed lot did little to improve overall seed vigor or increase crop yield as they only constituted 8% of the original unscreened seed lot. The quality of the small seed in this seed lot was still good and tested 98% vigor. However, this may not always be the case and it still may be a good practice for producers to remove thin seed from seed lots they intend to plant. Increasing seeding rates from 100 to 300 seeds/m^2 did not improve yield at either location in this study. However, the high seeding rate should still be recommended as it hastened maturity by 4 days and reduced wild oat pressure at Indian Head.

Supporting Information

11. Acknowledgements:

This project was supported through the Saskatchewan Oat Development Commission and funded by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement. Adopt signs were posted and the project was highlighted during the annual tours at both locations.

12. Appendices

Table 1. Seed size and seeding rate effects on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].

Main effect	Emergence (plants/m²)	Oat Biomass (Kg/ha dry)	Maturity (days)	Test Weight (g/0.5 l)	Yield (kg/ha)
Effect	------------------------------------p-values [Z]			--------------------------------	
Seed size (S)	0.037	0.0031	Na	Ns	0.039
Seeding Rate (R)	<0.0001	0.0001	Na	0.0018	Ns
S x R	Ns	0.0042	Na	Ns	Ns

[Z] p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability
[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 2. Main effect means of seed size and seeding rate on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].

Main effect	Emergence (plants/m²)	Oat Biomass (Kg/ha dry)	Maturity (days)	Test Weight (g/0.5 l)	Yield (kg/ha)
<u>Seed Size</u>					
Large (42 mg/seed)	185 b	154 a	Na	256.1 a	6701b
Small (26 mg/seed)	162 a	130 a	Na	255.4 a	6189 a
Unscreened (41 mg/seed)	187 b	184 b	Na	255.1 a	6530 ab
<u>LSD</u>	21	29		3.42	397
<u>Seeding Rate</u>					
100 seeds/m²	109 a	112 a	Na	259.3 b	6632 a
200 seeds/m²	182 b	171 b	Na	253.1 a	6359 a
300 seeds/m²	243 c	184 b	Na	254.1 a	6429 a
<u>LSD</u>	21	29		3.42	397

[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 3. Means for seed size by seeding rate interactions on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].					
Main effect	**Emergence (plants/m^2)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
S x R					
Large Seed size – 100 seeds/m^2	112	130	Na	259.0	7008
Large Seed size – 200 seeds/m^2	178	141	Na	254.9	6441
Large Seed size – 300 seeds/m^2	264	191	Na	254.4	6655
Small Seed size – 100 seeds/m^2	107	102	Na	259.1	6131
Small Seed size – 200 seeds/m^2	163	169	Na	253.1	6304
Small Seed size – 300 seeds/m^2	217	118	Na	254.1	6131
Unscreened Seed – 100 seeds/m^2	108	104	Na	260.0	6758
Unscreened Seed – 200 seeds/m^2	205	204	Na	251.5	6332
Unscreened Seed – 300 seeds/m^2	249	243	Na	253.8	6501
L.S.D.	36	50		5.9	688

[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 4. Seed size and seeding rate effects on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence ($plants/m^2$)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Effect	---------------p-values ^{Z} ---------------				
Seed size (S)	0.056	<0.0001	0.0005	Na	Ns
Seeding Rate (R)	<0.0001	<0.0001	<0.0001	Na	Ns
S x R	Ns	Ns	Ns	Na	Ns

^{Z} p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability

[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 5. Main effect means of seed size and seeding rate on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence ($plants/m^2$)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Seed Size					
Large (42 mg/seed)	215.0 a	243.3 b	87.2 a	Na	4434 a
Small (26 mg/seed)	207.1 a	174.2 a	87.7 b	Na	4367 a
Unscreened (41 mg/seed)	231.0 a	254.8 b	87.0 a	Na	4550 a
LSD	Ns	32.5	0.32		Ns
Seeding Rate					
100 $seeds/m^2$	122.2 a	155.5 a	89.6 c	Na	4591 a
200 $seeds/m^2$	214.1 b	232.8 b	87.0 b	Na	4416 a
300 $seeds/m^2$	316.9 c	284.0 c	85.4 a	Na	4344 a
LSD	19.8	32.5	0.32		Ns

[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 6. Means for Seed Size by Seeding rate interactions on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence (plants/m^2)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
S x R					
Large Seed size – 100 seeds/m^2	116	164	89.8	Na	4695
Large Seed size – 200 seeds/m^2	215	244	86.6	Na	4314
Large Seed size – 300 seeds/m^2	315	322	85.1	Na	4292
Small Seed size – 100 seeds/m^2	124	118	89.8	Na	4464
Small Seed size – 200 seeds/m^2	193	181	87.5	Na	4402
Small Seed size – 300 seeds/m^2	305	224	85.9	Na	4236
Unscreened Seed – 100 seeds/m^2	127	185	89.3	Na	4615
Unscreened Seed – 200 seeds/m^2	235	274	86.8	Na	4532
Unscreened Seed – 300 seeds/m^2	331	306	85.1	Na	4505
L.S.D.	34	56	0.56		Ns

[1]Treatments 1-9 used in factorial analysis (3 seed sizes by 3 seeding rates). Seeding depth for all treatments was shallow.

Table 7. Seed size and seeding depth effects on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].					
Main effect	**Emergence (plants/m²)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Effect	----------p-values [Z] ----------				
Seed size (S)	0.0095	0.076	Na	0.0096	0.15
Seeding Depth (D)	Ns	Ns	Na	0.12	0.14
S x D	Ns	0.068	Na	Ns	Ns

[Z] p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability
[1]Treatments 2, 5, 8, 10, 11, 12 used in factorial analysis (3 seed sizes by 2 seeding depths).
Seeding rate for all treatments is (200 seeds/m²).

Table 8. Main effect means of seed size and seeding depth on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].					
Main effect	**Emergence (plants/m²)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Seed Size					
Large (42 mg/seed)	179 ab	162 a	Na	256.6 b	6785
Small (26 mg/seed)	163 a	136 a	Na	255.5 b	6444
Unscreened (41 mg/seed)	197 b	187 a	Na	250.8 a	6302
LSD	21	Ns		3.7	Ns
Seeding Depth					
Shallow (1”)	182 a	170 a	Na	253.1 a	6359
Deep (3”)	177 a	154 a	Na	255.5 a	6661
LSD	Ns	Ns		Ns	Ns

[1]Treatments 2, 5, 8, 10, 11, 12 used in factorial analysis (3 seed sizes by 2 seeding depths).
Seeding rate for all treatments is (200 seeds/m²).

Table 9. Means for Seed Size by Seeding Depth interactions on oat emergence, biomass, maturity, test weight and yield at Yorkton in 2018[1].

Main effect	**Emergence (plants/m^2)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
S x D					
Large Seed size – Shallow	178	141	Na	254.9	6441
Large Seed size – Deep	180	183	Na	258.4	7128
Small Seed size – Shallow	179	164	Na	253.1	6304
Small Seed size – Deep	163	109	Na	257.9	6584
Unscreened Seed – Shallow	204	204	Na	251.5	6332
Unscreened Seed – Deep	190	169	Na	250.1	6272
L.S.D.	30	Ns		5.2	NS

[1]Treatments 2, 5, 8, 10, 11, 12 used in factorial analysis (3 seed sizes by 2 seeding depths). Seeding rate for all treatments is (200 seeds/m^2).

Table 10. Seed size and seeding depth effects on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence (plants/m²)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Effect	--p-values ^{Z} --				
Seed size (S)	0.037	0.055	0.0072	Na	Ns
Seeding Depth (D)	0.10	0.007	0.001	Na	Ns
S x D	Ns	0.059	Ns	Na	Ns

^{Z} p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability
[1]Treatments 2, 5, 10, 11 used in factorial analysis (2 seed sizes by 2 seeding depths). Seeding rate for all treatments is (200 seeds/m²).

Table 11. Main effect means of seed size and seeding depth on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence (plants/m²)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
Seed Size					
Large	207 a	204 a	87.2 a	Na	4308
Small	180 b	172 a	87.9 b	Na	4346
LSD	26	34	0.52		Ns
Seeding Depth					
Shallow (1”)	204 a	212 b	87.1 a	Na	4358
Deep (3”)	183 a	163 a	88.1 b	Na	4296
LSD	26	34	0.52		Ns

[1]Treatments 2, 5, 10, 11 used in factorial analysis (2 seed sizes by 2 seeding depths). Seeding rate for all treatments is (200 seeds/m²).

Table 12. Means for Seed Size by Seeding Depth interactions on oat emergence, biomass, maturity, test weight and yield at Indian Head in 2018[1].					
Main effect	**Emergence (plants/m^2)**	**Oat Biomass (Kg/ha dry)**	**Maturity (days)**	**Test Weight (g/0.5 l)**	**Yield (kg/ha)**
S x D					
Large Seed size – Shallow	215	244	86.6	Na	4314
Large Seed size – Deep	199	163	87.8	Na	4302
Small Seed size – Shallow	193	181	87.5	Na	4402
Small Seed size – Deep	167	163	88.4	Na	4290
L.S.D.	NS	48	0.74		Ns

[1]Treatments 2, 5, 10, 11 used in factorial analysis (2 seed sizes by 2 seeding depths). Seeding rate for all treatments is (200 seeds/m^2).

Abstract

13. Abstract/Summary:

The objective of this study was to demonstrate the benefit of screening out the small seed from an oat seed lot. Small seed tends to be less vigorous and its removal before planting can increase crop competition and yield. A seed lot of CS Camden was screened to remove the small seed constituting 8% of the original mass. This created 3 seed lots of large (42 mg/seed), small (26 mg/seed) and unscreened (41 mg/seed) seed sizes. These 3 different seed size lots were planted shallow at 100, 200 and 300 seed/m^2 near Yorkton and Indian Head. In addition, each lot was also seeded deep at 200 seed/m^2. While the vigor of the seed lots all tested over 98%, oats grown from small seed was found to be less vigorous than oats from large seed under field conditions. Plants grown from small seed had reduced emergence and less early-season above ground biomass at both locations. Oats grown from the large seed yielded 8% higher than with the small seed at Yorkton but seed size did not significantly affect yields at Indian Head. In the field, large seed size oats did not statistically outperform the unscreened seed by any measure at either location. While oats from small seed was less vigorous, there was little evidence that their removal was enough to significantly improve the vigor over the original seed lot as they constituted 8% of the original mass. Increasing seeding rates from 100 to 300 seeds/m^2 did not improve yield at either location in this study. However, the high seeding rate should still be recommended as results may differ under more optimal conditions and it hastened maturity by 4 days and reduced wild oat pressure at Indian Head.